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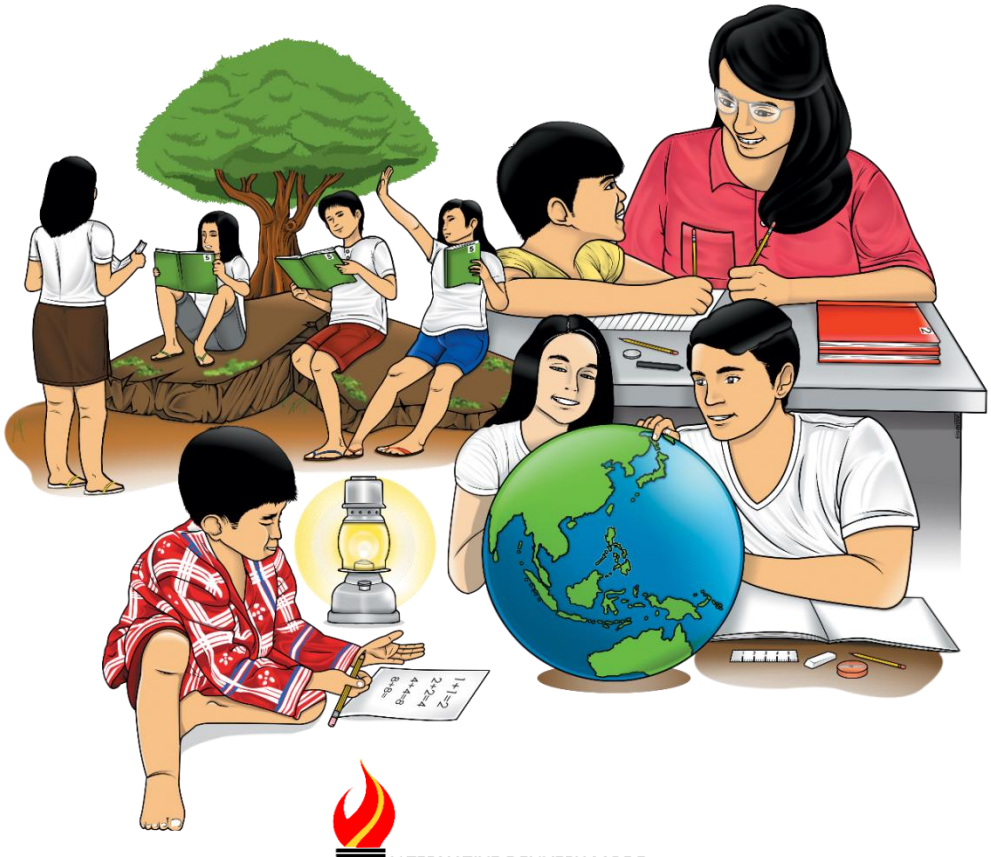
Science

Quarter 4 - Module 1: The Horizontal and Vertical Motions of a Projectile



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ADM

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Science

Quarter 4–Module 1:
The Horizontal and Vertical Motions of a Projectile

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

In this module, you will learn the definition of projectile different from projectile motion. You will also learn on how to describe the horizontal and vertical motions of a projectile. And lastly, you can be able to explain horizontal and vertical motions of a projectile. Activities are here inside for you. So, start your engine! For we are about to explore the following lessons:

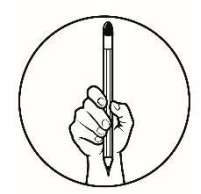
1. Projectile Motion; and
2. The Horizontal and Vertical Motions of a Projectile.

The module focuses on achieving this learning competency:

Describe the horizontal and vertical motions of a projectile. Code: S9FE-IVa-34

After going through this module, you are expected to:

1. Define concepts involving projectile and projectile motion
2. Describe the horizontal and vertical motions of a projectile
3. Cite examples and explain the horizontal and vertical motions of a projectile under various cases.



What I Know

Multiple Choice: Read the following items carefully. On your answer sheet, write the letter of the BEST ANSWER from the given options.

1. Which of the following composed the two linear motions of a projectile?
   A. Horizontal and Circular Motion
   B. Vertical and Circular Motion
   C. Horizontal and Vertical Motion
   D. Vertical and Curvilinear Motion

2. What is referred to as an object that is given an initial velocity and is then acted solely upon by gravitational force?
   A. Project
   B. Projectile
   C. Target
   D. Trajectory

3. What do you call the path followed by a projectile?
   A. Project
   B. Projectile
   C. Target
   D. Trajectory

4. What is the shape of the trajectory of a projectile?
   A. Circular
   B. Elliptical
   C. Hyperbolic
   D. Parabolic

5. What force enables objects to fall on to the ground?
   A. Frictional Force
   B. Magnetic Force
   C. Gravitational Force
   D. Tension Force

6. If you throw a baseball straight up, what will its vertical velocity be at the highest point?
   A.0m/s
   B.9.8m/s
   C. $0m/s^2$
   D.$-9.8m/s^2$

7. What is the acceleration of a baseball thrown to the air at an angle of 45 degrees with respect to the horizontal as it returns to the ground?
   A.0m/s
   B.9.8m/s
   C.$0m/s^2$
   D.$-9.8\ m/s^2$

8. What happens to the vertical velocity of an object as it travels through the air?
   A. Changes continuously
   B. Gradually decreasing
   C. Gradually increasing
   D. Remains the same

9. What happens to the horizontal velocity of an object as it travels through the air?
   A. Changes continuously
   B. Gradually decreasing
   C. Gradually increasing
   D. Remains the same

10. If a stone is horizontally launched at a certain height, how do you describe the magnitude of its vertical velocity as it approaches the ground?
   A. Cannot be determined
   B. Gradually decreasing
   C. Gradually increasing
   D. Remains the same

Lesson 1 Projectile Motion

From your previous academic years especially in Grade 7, you've learned about the descriptors of motion in one dimension which govern on moving objects traveling in either two of the straight lines at uniform acceleration (constant acceleration): the horizontal (motion on a straight line) and vertical motions (free-fall).

Specifically, you will be able to:

1. Define what a projectile and projectile motion is.
2. Illustrate the path travel by a projectile
3. Appreciate the application of projectile motion in relation to sports

What's In

Uniform acceleration is when the speed of an object changes at the same rate. This leads to the study of motion using equations and known as **kinematics.** Knowing details such as how fast an object is going after a given time interval rather than just the fact that the object is moving is our primary interest. To describe the properties, characteristics and behavior of motion with greater detail the following equations were discussed.

Table1: Kinematic Equations (horizontal motion)

Kinematic Equations	Variables Involved				
	x	T	a	v_x	v_{ox}
$\Delta x = v_{ox}t + \frac{1}{2}at^2$	/	/	/		/
$v_x^2 = v_{ox}^2 + 2a\Delta x$	/		/	/	/
$v_x = v_{ox} + at$		/	/	/	/
$\Delta x = \frac{1}{2}(v_x + v_{ox})t$	/	/		/	/

The four kinematic equations can be utilized to predict the unknown information about an object's motion if other information is present. These equations can only be utilized if the motion undergoes constant velocity (a = 0) or a motion having a constant acceleration.

The motion of objects acted solely by gravity is also an example of uniform acceleration having a constant value of $g = -9.8\,{}^{m}/_{s^2}$.("-" means downward). It is associated with free-falling objects and objects thrown vertically straight to the air. With this, we also transform our Kinematic Equations along the horizontal to Kinematic Equations along the vertical by changing variable **x to y and a to g.**

Table2: Kinematic Equation (vertical motion)

Kinematic Equations	Variables Involved				
	y	t	g	v_y	v_{oy}
$\Delta y = v_{oy}t + \frac{1}{2}gt^2$	/	/	/		/
$v_y^2 = v_{oy}^2 + 2g\Delta y$	/		/	/	/
$v_y = v_{oy} + gt$		/	/	/	/
$\Delta y = \frac{1}{2}(v_y + v_{oy})t$	/	/		/	/

***Note**: y - height, t - time, g - gravitational acceleration ($-9.8\,{}^{m}/_{s^2}$), v_y - final velocity v_{oy}- along y, v_{oy} - initial velocity along y*

There are few conceptual characteristics of free fall motion that you need to recall in applying the equations from the above table:

- An object in free-fall experiences an acceleration of -9.8m/s^2. (The negative sign indicates a downward acceleration) Whether explicitly stated or not, the value of the acceleration in the kinematic equations is -9.8 m/s^2 for any freely falling object.

- If an object is merely dropped (as opposed to being thrown) from an elevated height, then the initial velocity of the object is 0 m/s.

- If an object is projected upwards in a perfectly vertical direction, then it will slow down as it rises upward. The instant at which it reaches the peak of its trajectory,its velocity is 0 m/s. This value can be used as one of the motion parameters in the kinematic equations;

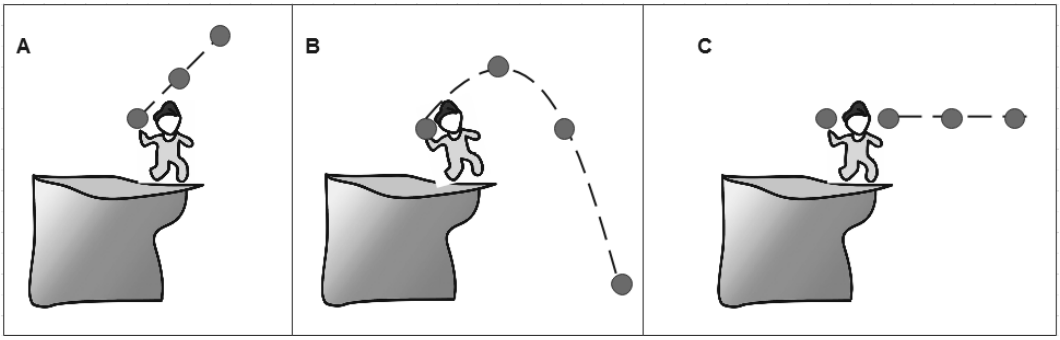
- If an object is projected upwards in a perfectly vertical direction, then the velocity at which it is projected is equal in magnitude and opposite in sign to the velocity that it has when it returns to the same height.

For this lesson, you will learn the definition of projectile motion and the associated concepts. Furthermore, we will learn that projectile motion consists of two motions where we can apply the kinematic equations for both vertical and horizontal motions.

What's New

Which of the three situations is/are more likely to happen in real-life? Write your explanation on your answer sheet.

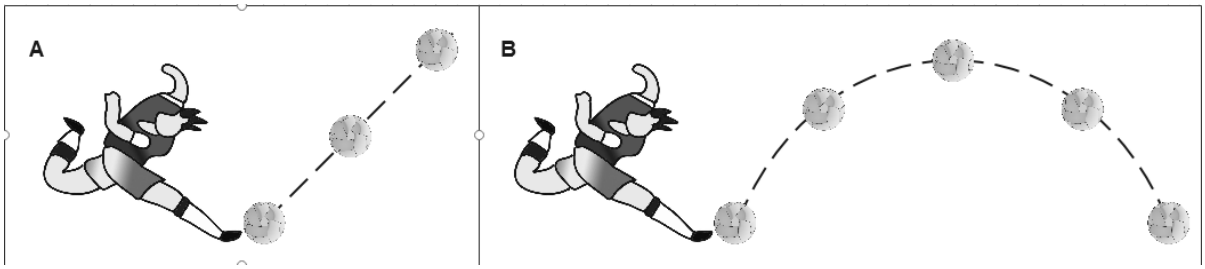
Figure 1.1: Ball thrown by a man at the cliff



Illustrated by: Jumari S. Sapio

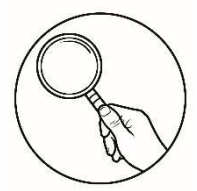
In addition, supposed you were able to use a stroboscope in observing a player playing sepak takraw. As the player kicks the rattan ball, you observed the motion of the rattan ball.

Figure1.2: Sepak takraw player kicking a rattan ball



Illustrated by:Jumari S. Sapio

What will be your observations as you look into the motion of the ball on a strobe? Is it situation A or situation B? What do you think would be the explanation?



What is It

Projectile motion is a form of motion where an object given an initial velocity is thrown or projected and is allowed to be acted on by gravity in a curved-like path. These objects are called **projectiles.** The curved path followed by a projectile is called a **trajectory.**

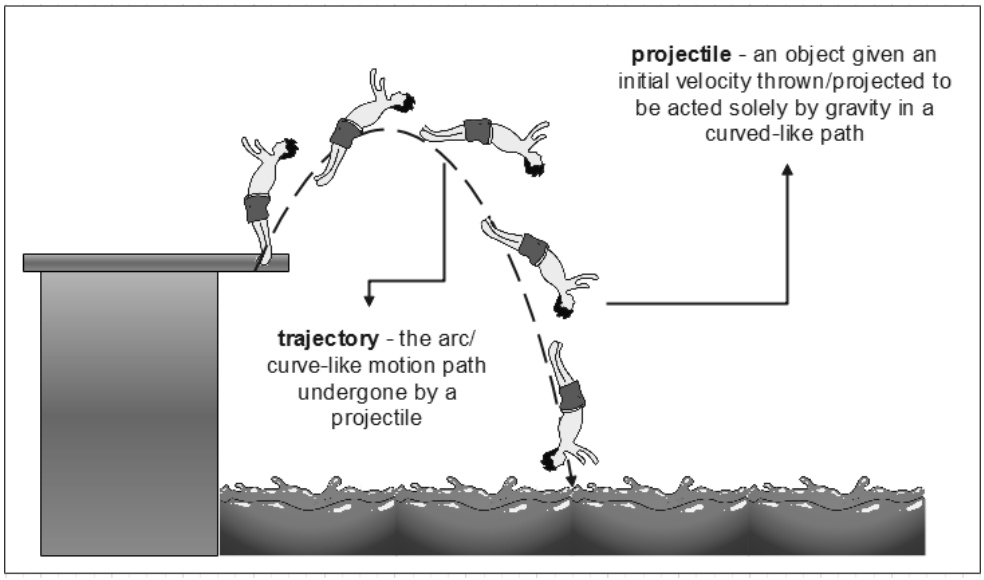
In projectile motion, the physical principles and mathematical formulas that must be applied are those concepts that were recalled earlier. Combining the two allows us to make predictions concerning projectile motion. As such the principles and formulas are well understood in various types of projectile problems.

Type 1: Horizontally Launched Projectiles

Horizontally launched projectiles are projectiles that are launched with an initial velocity from an elevated position and follows a curved-like path to the ground.

Consider the figure below.

Figure 1.3: A man diving into the water



Illustrated by: Jumari S. Sapio

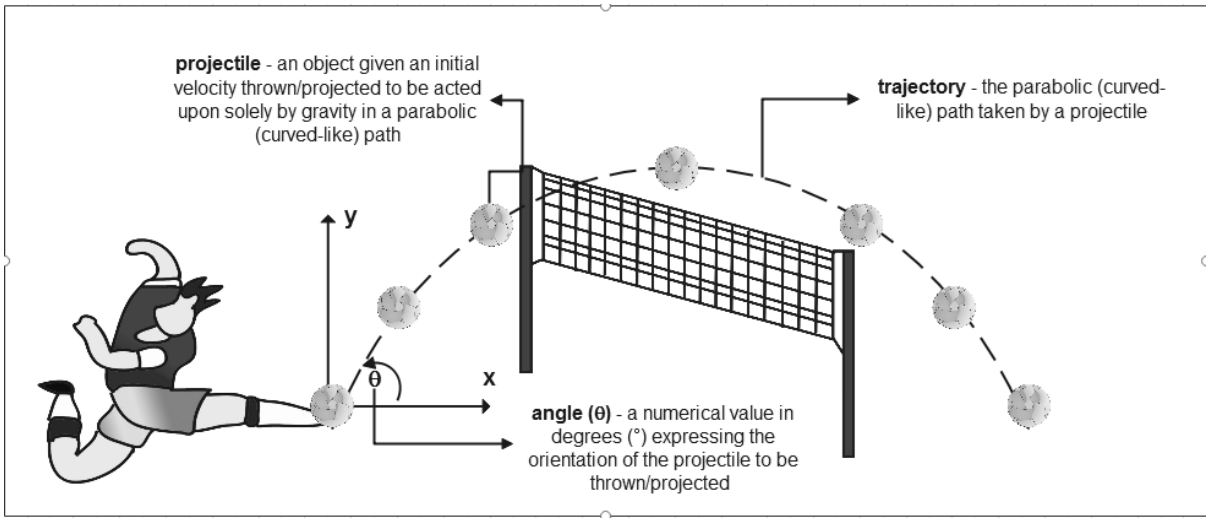
In Figure1.3, the motion of the man as it dives into the water is moving along a curved path downwards due to a natural force called gravitational force of the earth or gravity. Gravity is the natural force that causes objects to fall towards the earth. Hence, the acceleration due to gravity is always directed downwards and has a value of -9.8m/s^2. With this, the motion of the man undergoes projectile motion.

Type 2: Angle-Launched Projectiles

Angle-launched projectiles are projectiles launched at an angle with respect to the horizontal and rises to a peak while moving horizontally. Upon reaching the peak, the projectile falls with a motion that is symmetrical to its path upwards to the peak.

Consider the situation below.

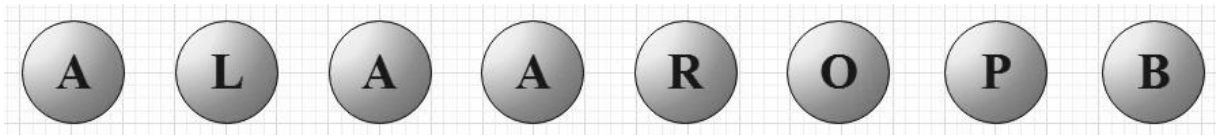
Figure 1.4: A sepak takraw player kicking a rattan ball over the net



Illustrated by: Jumari S. Sapio

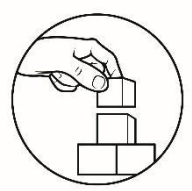
What is the projectile in Figure 1.4? If you think that the rattan ball is the projectile, then you are right! How do you describe its trajectory? The rattan ball is travelling on a curved path. In mathematical terms, what do you call this pattern? Try to rearrange the following letters for you to answer the question.

Figure1.5: Scrambled bubble letters



Illustrated by: Jumari Sapio

` If you got the term **parabola**, then you were right! An angle-launched projectile exhibits a full parabolic trajectory motion. This shows that as the player kicked the rattan ball in the air, the ball will eventually go back to the ground still due to gravity as it moves horizontally. Hence projectile motion consists of horizontal and vertical motion working independently.



What's More

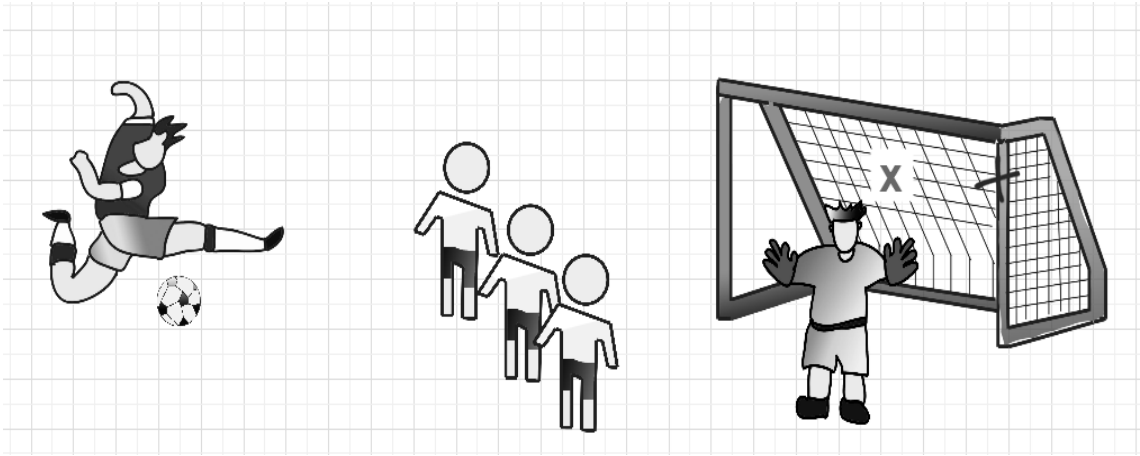
Activity1.1: Sketch Me Quick

Situation1: Free Kick!

Sam was given a free kick. Illustrate the trajectory of the ball in order for Sam to get a goal. On your answer sheet, explain how you came up with that trajectory.

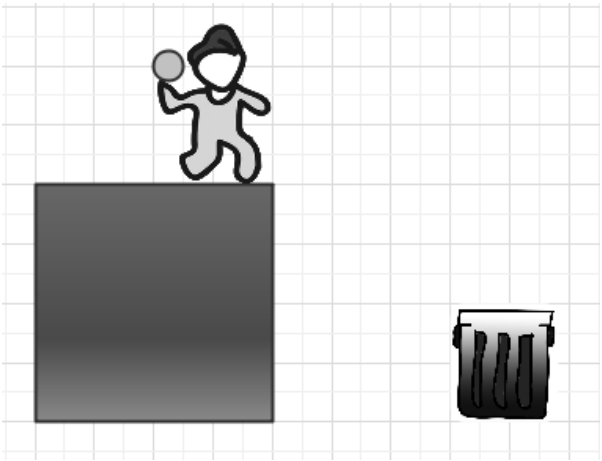
Figure1.6: Free kick scenario in soccer.
Illustrated by: Jumari S. Sapio

Situation 2: Throwing of Garbage



Mat wants to shoot a crumpled paper inside the trash bin. Help him shoot his garbage right at the trash can by illustrating the trajectory. Explain below how you ended up with that trajectory.

Figure 1.7: Throwing crumpled paper into a trash bin



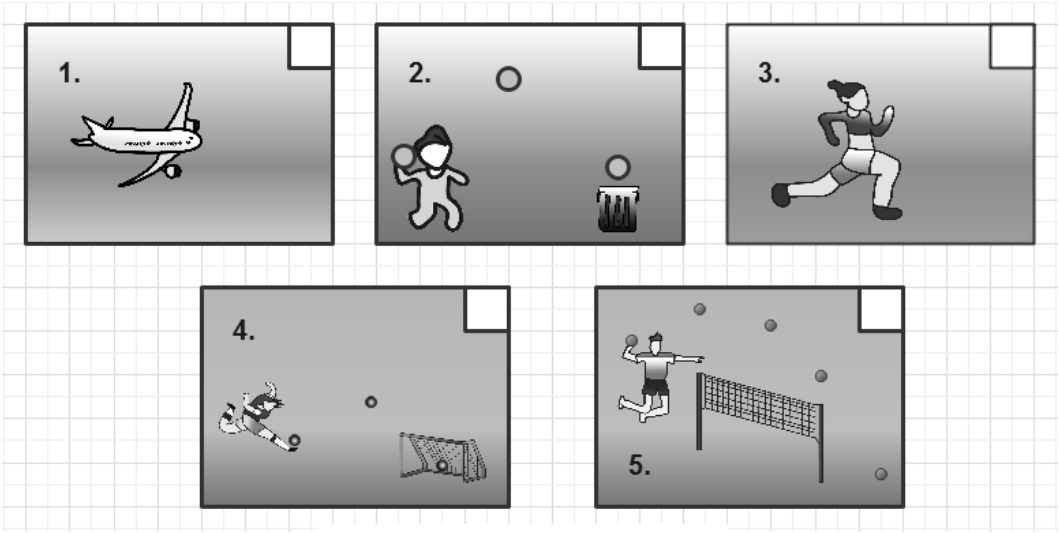
Illustrated by: Jumari S. Sapio

What I Have Learned

Activity 1.2: Quiz Time!

I. Identify if the following illustrations show projectile motion or not. Put a (/) if it's a projectile and (X) mark if it's not.

Figure1.8: Check-boxed illustrations

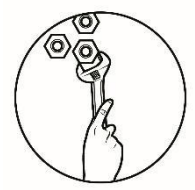


Illustrated by: Jumari Sapio

I. Inside the box is a list of sports/games. Classify the sports/games whether they exhibit projectile motion or not. Complete the table on your answer sheet.

A VOLLEYBALL BEING SERVED	**A MOTORBIKE TAKING OFF ON A RAMP**	**A FLIGHT OF A SOCCER BALL**	**CAR RACING**	**SMASHING OF SHUTTLE COCK**
100m DASH	**A BASEBALL HIT BY A BAT**	**DRAGONBOAT PADDLING RACE**	**SLICE SERVING OF THE PINGPONG BALL**	**SHORT COURSE SWIMMING**

PROJECTILE MOTION	**NON-PROJECTILE MOTION**
e.g A VOLLEY BALL BEING SERVED	**CAR RACING**



What I Can Do

Activity 1.3: World of Sports!

Accomplish the table below by listing a set of five different sports activities that can be considered to involve projectile motion.

Sports	**Projectile**	**Way in Achieving Projectile Motion**
Example: Long Jump(Athletics) Discus Throw	Athlete Discus	Jumping from one point to his/her longest reach. Throwing the discus Through the air.
1. 2. 3. 4. 5.		

Lesson 2 The Horizontal and Vertical Motion of a Projectile

What I Need to Know

At the end of this lesson you will be able to understand the vertical and horizontal motions of a projectile.

Specifically, you will be able to:

1. Identify the horizontal and vertical motions of a projectile.
2. Explain horizontal and vertical motions of a projectile.

What's In

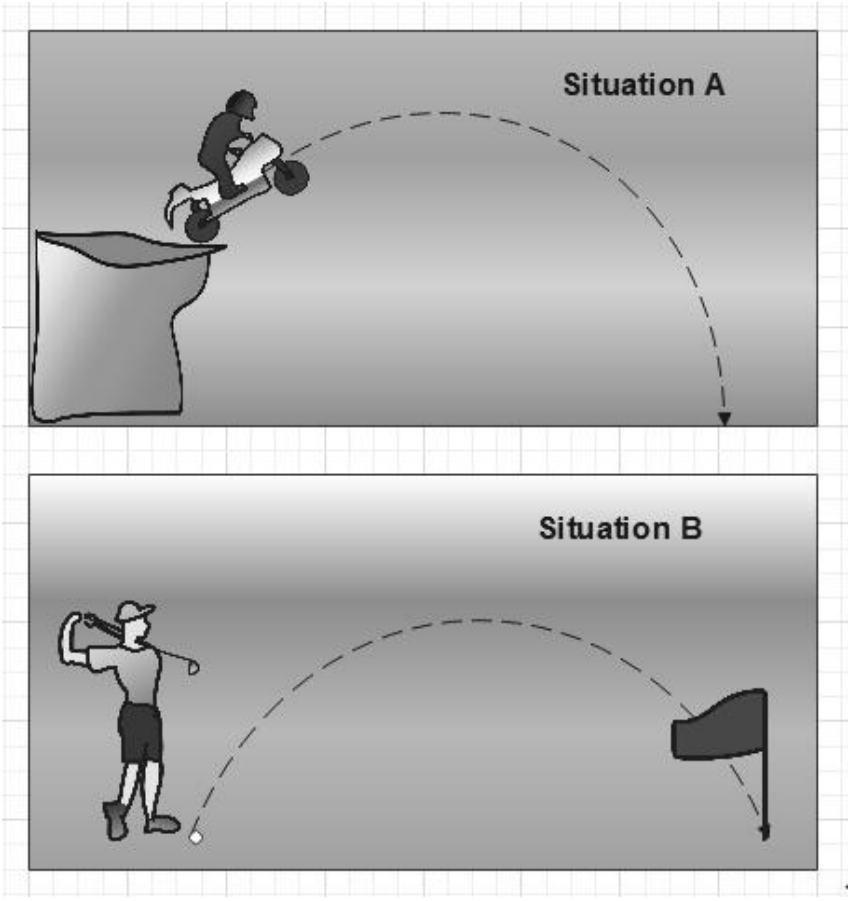
In your previous lesson you already know the basic characteristics of a projectile motion. Projectile motion is a form of motion where an object (projectile) moves in a parabolic (curved-like) path (trajectory). You have also found out that the motion of a projectile consists of two motions working independently the horizontal motion (motion along x) and the vertical motion (motion along y).

For this lesson, you will learn more about the horizontal and vertical components of projectile motion. Since horizontal and vertical motions are independent of each other, we will discuss them separately.

What's New

Consider the rider as it takes off a cliff and the golf ball as it flies into the air and returns back to the ground.

Figure 2.1: (top) rider taking off from a cliff; (bottom) a golf ball flies into the air and returns back to the ground

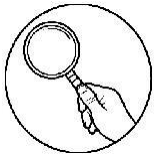


Illustrated by: Jumari Sapio

Guide Questions:

Try to answer the following questions and explain the possible reasons for each item.

1. What do you think is the projectile in situation A? In situation B?
2. What happens to the motion of the rider as it takes off from the cliff?
3. What happens to the vertical velocity (v_y) of the golf ball as it rises in the air (it increases, it decreases)
4. When the golf ball reaches the maximum height what happens to the vertical velocity?
5. When the golf ball returns to the ground the vertical velocity will (increase, decrease)

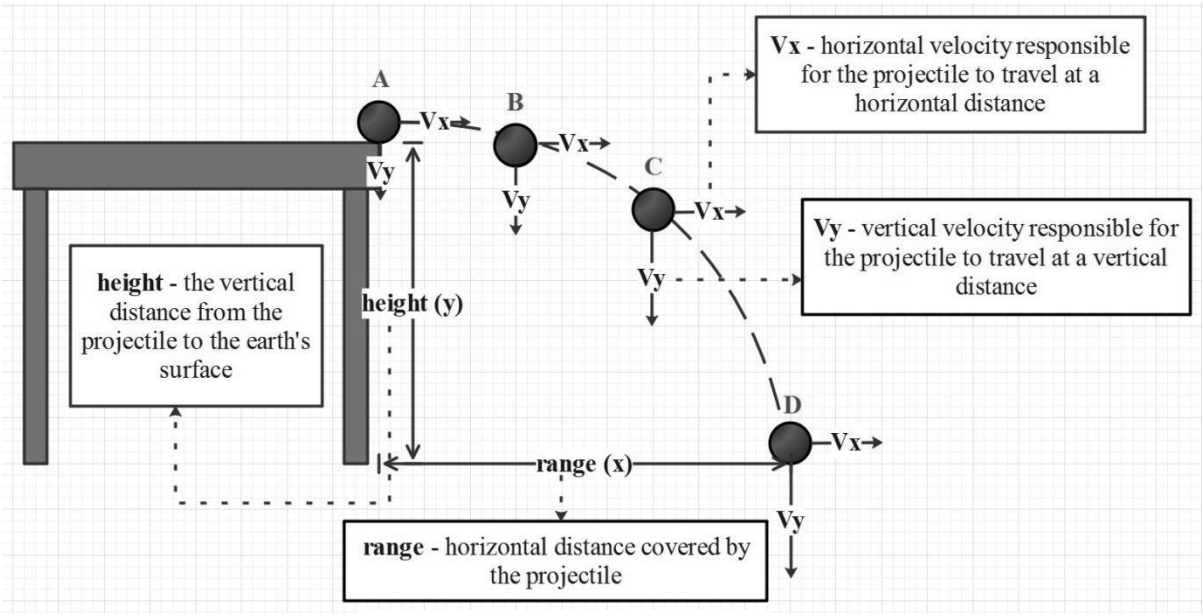


What Is It

Type I: Horizontally Launched Projectiles

Suppose you roll a marble on a frictionless table, observe the motion of the marble as it goes down the floor. The following illustration is a strobe of the falling marble.

Figure 2.2: Motion diagram of a marble falling from a table



Illustrated by: Jumari Sapio

From Figure 2.2 the vertical velocity of the marble is gradually increasing from points A to D (as illustrated by the increasing downward arrows). Due to the presence of gravity accelerating at the marble -9.8 m/s^2 this causes the vertical velocity (v_y) to increase.

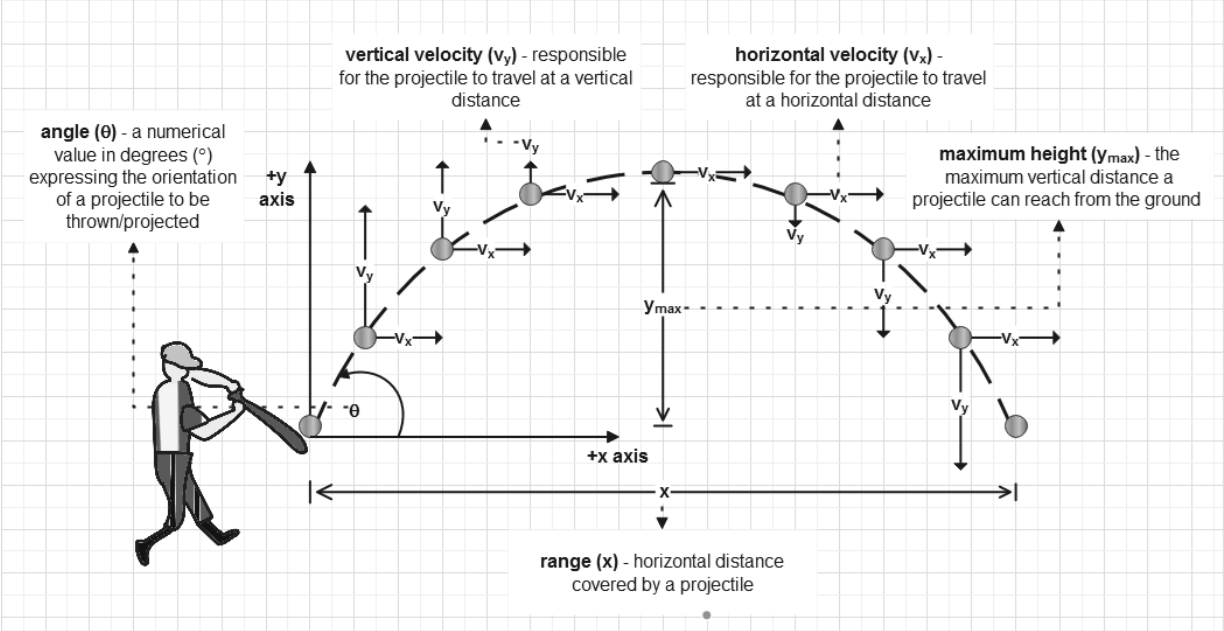
For the horizontal velocity (v_x), there is no external net force acting along the horizontal direction which means that there is no acceleration along this direction (ax=0), resulting to a constant horizontal velocity (v_x) as illustrated by a consistent set of horizontal rays to the right for each of the location of the marble in the strobe.

Hence from Figure 2.1, when the rider takes off from the cliff its downward vertical velocity is increasing due to the presence of gravity which accelerates the rider at 9.8m/s interval downward.

Type II: Angle-Launched Projectiles

From the illustration below, discuss the motion of the baseball as it was hit by a bat.

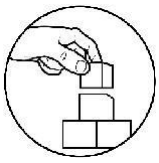
Figure 2.3: Motion diagram of a baseball as it was hit by a bat



Illustrated by: Jumari Sapio

For angle-launched projectiles, horizontal velocity (v_x) is still constant while the vertical velocity can be described in three parts. From Figure 2.3, it is observed that as **the projectile ascends (point A to B) the upward vertical velocity (v_y) is decreasing**, this is because the direction of gravity is opposite to the projectile motion. As the projectile **reaches the maximum height (point B) it momentarily stops** causing a vertical velocity equal to zero ($v_y = 0$). **When the projectile descends (point B to C) the direction of its motion is in the direction of the gravitational force hence the magnitude of its vertical velocity is increasing.**

So, in Figure 2.3 the vertical velocity of the baseball as it rises to the air decreases due to the opposing direction of gravity compared to its motion. When the baseball reaches the maximum height, its vertical velocity becomes zero. When it descends its vertical velocity increases since the direction of the baseball's motion is the same with gravity.



What's More

Activity 2.1: Modified True or False!

Write TRUE in the space provided if the following statements are correct and if false, change the underlined word or phrase to make the statement/s correct

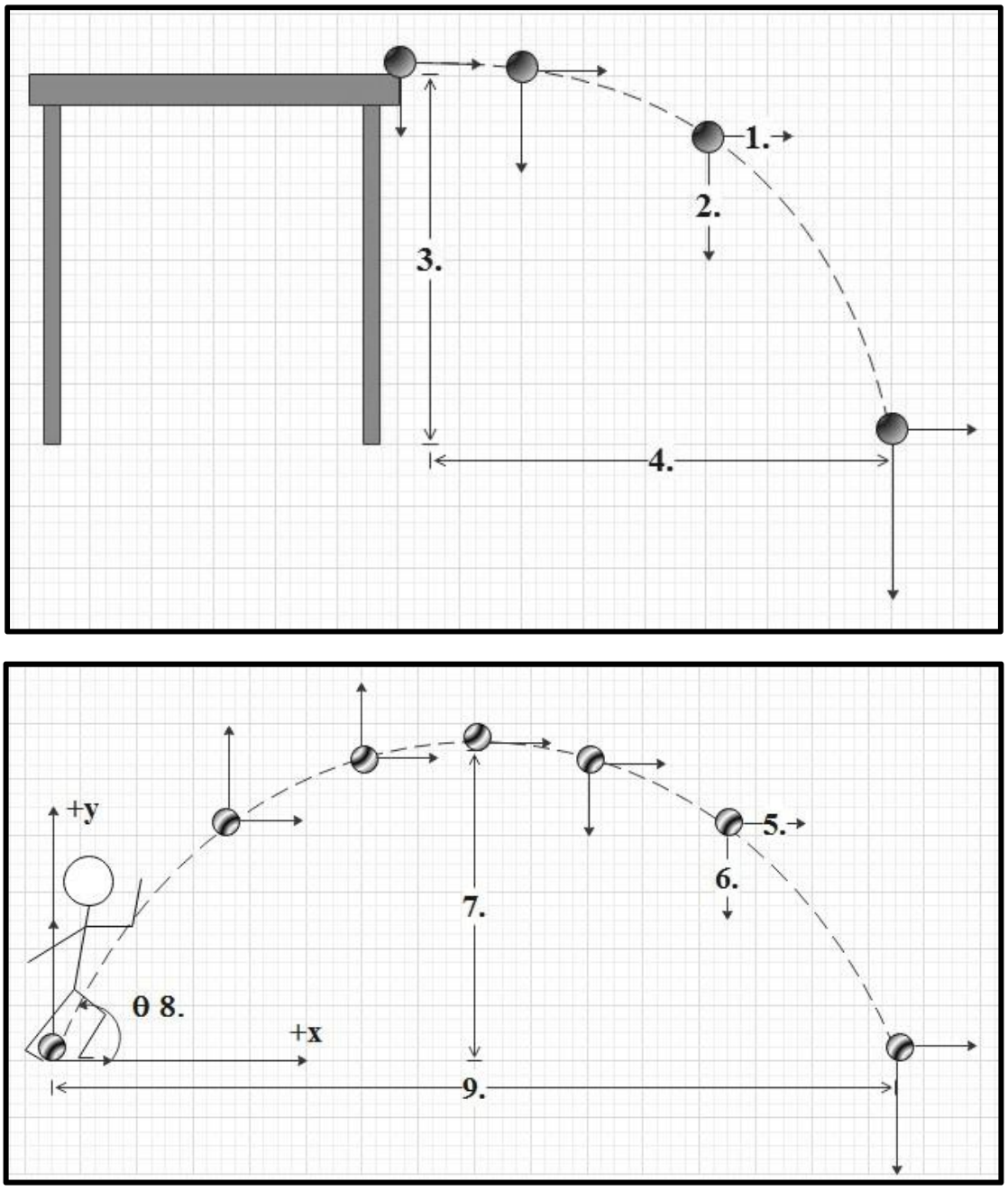
1. As the projectile reaches its highest peak, the vertical velocity <u>continuously increases</u>.
2. When an object is horizontally launched its motion <u>gradually increases.</u>
3. In an angle-launched projectile the vertical velocity <u>remains constant.</u>
4. As the projectile reaches the maximum height its vertical velocity becomes <u>zero.</u>
5. The horizontal acceleration (a_x) of a projectile is equal to <u>$9.8 m/s^2$</u>
6. The horizontal velocity in horizontally launched projectile is <u>constant</u>.
7. In angle-launched projectile, as the projectile rises its vertical velocity <u>decreases.</u>
8. The acceleration due to gravity is equal to <u>zero</u>.
9. As a projectile approach to the ground its vertical velocity <u>decreases.</u>
10. There is <u>external force</u> acting on the horizontal motion of a projectile.

What I Have Learned

Activity 2.2: Complete the Diagram

From the set of quantities involved in projectile motion (***height, range, vertical velocity, horizontal velocity, angle***), complete the diagram showing the two types of projectile launched by writing on the numbers the correct quantity.

Figure 2.4: Motion diagrams of the types of projectile motion



Illustrated by: Jumari Sapio

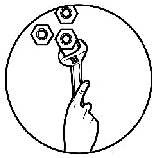
Activity 2.3: Quiz Time!

I. **True or False**: Write TRUE in the space provided if the statement is correct and write FALSE if the statement is incorrect. In a separate paper attached your explanation why the statement is true or false in this page. (3 points each).

_____1. The horizontal velocity (v_x) in horizontally launched projectiles is always constant.
_____2. In angle-launched projectile, the vertical velocity (v_y) decreases as the projectile rises.
_____3. In angle-launched projectile, the projectile's vertical velocity becomes zero at its maximum height.
_____4. The vertical velocity (v_y) of a projectile that descends, decreases in angle-launched projectiles.

II. **Fill in** the table below if the quantities are present in either horizontal or vertical motion. Assume air resistance to be zero.

Quantity	**Horizontal Motion**	**Vertical Motion**
Forces (Is it Present? – Yes or No, if present, in what direction?)	No	Yes, downward
Acceleration (2 points each) (Is it Present? – Yes or No, if present, in what direction?)		
Velocity (1 point each) Is it changing or constant?		



What I Can Do

Activity 2.4: Draw Time!

The Scenario

It was morning of January 21, 2021, you heard a distant gunshot. You went outside and found out that the neighbor's rooster was dead with a gunshot wound. Immediately the barangay police together with the crime investigators looked into the case. They gathered some information that would help solve the case.

As a witness, your job is to help investigators pinpoint the location at which the shots originated by illustrating the scene. The details in the incident are stated below.

Crime Scene Notes:

The bullet that entered the rooster's body has been matched to a .45 caliber pistol. This gun releases bullets with an exit velocity of 260m/s. The bullet entered the rooster at an angle of 12 degrees from the horizontal.

The following suspects in the neighborhood are registered owners of .45 caliber pistols. The suspects were also found in their residence during the time of the incident.

Arthur Abellardo: He has a record of noise violations for loud parties he frequently holds at his residence 2.54 kilometers away from the crime scene.

Carlos Sarial: He has no criminal record and residing 2.8 kilometers away from the crime scene.

Ramon Ricorda: Ramon has a record that includes possession of prohibited drugs. He served time in prison and was released after the completion of his sentence. He is currently residing 3.05 kilometers away from the crime scene.

The rooster was lying on the ground when it was shot. The fence is 1.73 m above the ground where the rooster was.

Note: Focus only in making the illustration/sketch. Calculating and solving the case is not required. Rubrics can be found on the next page.

Disclaimer: The characters, places, incidents in the scenario are hypothetical. Any resemblance to actual persons living or dead or actual events are purely coincidental.

Rubrics for Activity 2.4:

Criteria	Excellent (4)	Satisfactory (3)	Developing (2)	Beginning (1)
Art Skill	Perform skills, and/or express creativity at a high level.	Perform skills, and/or express creativity at a proficient level.	Perform skills, and/or express creativity at a basic level.	Does not perform skills, and/or express creativity at an appropriate level.
Approach to the situation given	Clear and Concise organized method	Appropriate method is used to illustrate the situation	Begins in a reasonable way, but does not finish important parts of the Situation	Begins but fail to complete
Explanation	Demonstrates thinking with a clear and elaborate explanation	Explanation is clear and correct	Explanation is basic and incomplete	Explanation is unclear and erroneous
Organization of thought	The idea is very clear	The idea is well thought	The idea shows some Jumbled parts	Lack of idea to the situation

This activity is a task for you to look into a problem or issue related to projectile motion. How did you find the activity? How did the activity help you see the real world use of the topic?

Congratulations my dear learner, you have completed this module. You may now proceed to the next module. Keep up the good work!

Summary

- Projectile motion may be described using descriptions of horizontal and vertical motion.

- A projectile is an object that is given an initial velocity and is then acted solely upon by gravitational force.

- A trajectory is a path followed by a projectile.

- The path of an object under projectile motion follows a parabola.
- Because of gravity on earth and horizontal velocity, an object travels in a parabolic arc.

- As the object moves up, the magnitude of the vertical velocity (v_y) gradually decreases, thus it shows that the object is slowing down and has a vertical velocity of 0 m/s at its maximum height.

- As the object moves down, the vertical velocity (v_y) gradually increases, thus it shows that the object is speeding up which is influenced by a force due to gravity.

- The gravitational acceleration of projectiles on earth is constant and is equal to $-9.8\ {}^{m}/_{s^2}$ (means $-9.8\ {}^{m}/_{s^2}$ downward).

- In terms of horizontal component of a projectile, the horizontal velocity is constant. Thus, the initial and final horizontal velocities are equal ($v_{0x} = v_x$) which leads to a constant horizontal acceleration of $0\ {}^{m}/_{s^2}$.

- An object projected horizontally will fall down at the same rate as another one that is dropped, thus both objects will hit the ground at the same time.

- In horizontally launched projectile, the magnitude of the y-component of the velocity (v_y) gradually increases as it falls due to the acceleration due to gravity. On the other hand, the x-component of its velocity is constant since there is no net force acting on it and it is moving in accordance with the Law of Inertia.

- In angle-launched projectiles, the x-component of the velocity does not change since no net force is acting on the x-direction, it moves continuously due to inertia. The magnitude of the y-component of its velocity gradually decreases as it approaches the maximum height. As it reaches the maximum height its velocity along the y-axis becomes 0 m/s. As the projectile goes down, it gradually gains velocity along the -y-axis.

- In a gravity- and air resistance-free situation a projectile will move in a straight line due to the consequence of inertia.

Assessment

Multiple Choice: Read the following items carefully. On your answer sheet, write the letter of the BEST ANSWER from the given options.

1. What force enables objects to reach the ground?
   A. Frictional Force
   B. Magnetic Force
   C. Gravitational Force
   D. Tension Force

2. What is the shape of the trajectory of a projectile?
   A. Circular
   B. Elliptical
   C. Hyperbolic
   D. Parabolic

3. Which of the following composed the two linear motions of a projectile?
   A. Horizontal and Circular Motion
   B. Vertical and Circular Motion
   C. Horizontal and Vertical Motion
   D. Vertical and Curvilinear Motion

4. What is referred to as an object that is given an initial velocity and is then acted solely upon by gravitational force?
   A. Project
   B. Projectile
   C. Target
   D. Trajectory

5. What do you call the path followed by an object under projectile motion?
   A. Project
   B. Projectile
   C. Target
   D. Trajectory

6. What happens to the vertical velocity of an object as it travels through the air?
   A. Changes continuously
   B. Gradually decreases
   C. Gradually increases
   D. Remains the same

7. What happens to the horizontal velocity of an object as it travels through the air?
   A. Changes continuously
   B. Gradually decreases
   C. Gradually increases
   D. Remains the same

8. If you throw a baseball straight up, what is its vertical velocity at the highest point?

A.0m/s C.0m/s^2

B.9.8m/s D.-9.8 m/s^2

9. If a stone is horizontally launched at a certain height, how do you describe the magnitude of its vertical velocity as it approaches the ground?

A. Changes continuously C. Gradually increasing

B. Gradually decreasing D. Remains the same

10. What is the acceleration of a baseball thrown to the air at an angle of 45 degrees with respect to the horizontal as it returns to the ground?

A.0m/s C.0m/s^2

B.9.8m/s D.-9.8 m/s^2

Answer Key

What I know: Pre-test (iii)

1. C
2. B
3. D
4. D
5. C
6. A
7. D
8. A
9. D
10. C

What's New (p.3)

Figure 1.1: B since in real life objects projected in the air will fall to the ground

Figure 1.2: B since in real life objects projected in the air will fall to the ground

What I Have Learned (p.6)

I.
1. x
2. /
3. x
4. /
5. /

II.

ProjectileMotion	Non-ProjectileMotion
A Volleyball being served	CarRacing
	100m Dash
A Motor Cross taking off from the cliff	Dragon Boat paddling race
A flight of a Soccer Ball	
	Short Course Swimming
Smashing of shuttle cock	
A Baseball hit by a bat	
Slice serving of the ping pong ball	

What's More (p.16)

1. Becomes zero
2. TRUE
3. changes
4. TRUE $5.0 m/s^2$
6. TRUE
7. TRUE 8.$9.8 m/s^2$
9. increases
10. no external force

Assessment (p.19-20)

1. C
2. D
3. C
4. B
5. D
6. A
7. D
8. A
9. C
10. D

Activity 2.2 (p.17)

1. Horizontal velocity
2. Vertical velocity
3. Height
4. Range
5. Horizontal velocity
6. Vertical velocity
7. Height
8. Angle
9. Range

Activity 2.3 (p.18)

I. 1. True 2. True 3. True 4. False

II.

Quantity	Horizontal motion	Verticalm otion
Force	no	Yes,downwards
Acceleration	no	Yes,downwards
Velocity	constant	changing

References

Young, Hugh and Freedman, Roger. University Physics 12th edition with Modern Physics. Chapter 3: Motion in Two or Three Dimensions, Lesson 3.3 Projectile Motion, page79–96. ISBN- 13:978-0-321-50121-9, ISBN-10:0-321-50121-7. 2008.

PEAC. Learning Module Science G9| Q4: Force, Motion and Energy. Lesson 1.1: Projectile Motion, page 8–31.

The Physics Classroom.Vectors – Motion and Forces in Two Dimensions. Lesson 2: Projectile Motion. https://www.physicsclassroom.com/class/vectors/Lesson-2/What-is-a-Projectile?

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